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M E M O R A N D U M

To: Scott Tomashefsky, CEC
cc: Bill Cook, SDG&E;
Ed Grebel, SCE;
Mohammed Vaziri, PG&E
From: Jeff Newmiller, Chuck Whitaker 26 April 2002
Re: Plug Power Rule 21 Certification Review
Attachments: 4 April 2002 UL Memorandum (faxed hardcopy)
26 April 2002 Updated Plug Power Memorandum (Inverter Specs to EndeconV2.doc)

We have been corresponding with Plug Power to clarify the issues mentioned in the CEC teleconference on 3 April 2002. The status of the issues raised in that memo is resolved as follows:

Power factor: A statement from UL confirming the measured power factor is requested.

- Provided in 4 April 2002 UL memorandum.

DC isolation: Written UL clarification is requested that no measurement of dc injection was performed because due to the use of an isolating output transformer.

- Provided in 4 April 2002 UL memorandum.

Load transfer: Written UL clarification is requested that the device is only capable of operating while connected to the utility grid, and that this was the reason no load transfer test was performed.

- Provided in 4 April 2002 UL memorandum.

Anti-islanding tests: An updated UL test report that includes clarification regarding test data and result of test (passed) is requested.

- Data are provided in the 4 April 2002 UL memorandum. Time-to-disconnect measurements are all within required 2 second delay.

Voltage/frequency set-points: UL clarification is requested as to how the set point magnitudes and timings were measured and available data. At a minimum we request the "fixed" set-point values encoded in device; depending on the outcome of the review of available data, special tests to obtain measured confirmation of these values may be required.

- Provided in a memo from John Vogel of Plug Power to Chuck Whitaker dated 26 April 2002. (This is a revised version of a memo originally transmitted on 23 April 2002.)
  The UL testing followed only a portion of the New York Standard Interconnection Requirements input waveform: the parameter transition out of normal operating range. The subsequent transition back into operating range was not imposed for technical reasons, and measurement was used to identify the clearing time delay. This approach does not include any provision to measure the actual set point magnitude, though it very crudely brackets the trip point between the starting and ending magnitudes of the transition. UL is considering alternate test methods that would bracket the set point magnitudes to within a small range.
  The set point values (extended with their quoted accuracy) all fall within the required limits, and the review committee agreed that for this "small" generator the lack of independent confirmation of setpoint calibration may be acceptable.

The review summary table included in my memo to you dated 27 March 2002 is included here, updated to cover the points addressed above.

Tests (Required)	Description	Source	Reference	Verify Cross Reference	Value	Notes
Utility Disconnect	Pass?	D.1.a.2	UL1741 Section 39	File E182866, 01NK17676, V1S4P6	Y	Ac contactor in parts list
DC Isolation from Utility	Pass?	J.3	UL1741 Section 40.1	ULMemo, 20020404	Y	Passed by design review: Isolation transformer.
Input/Output Test Voltages	Pass?	J.3	UL1741 Section 41.2	File E206704, 01NK16753, V1S1P1	Y	
	Ac test voltage				240	
	Dc minimum input voltage				42	
	Dc maximum input voltage				90	
Dielectric Voltage Withstand	Pass?	J.3	UL1741 Section 44	File E206704, 01NK16753, PageT1-2	Y	
	Test voltage (ac rms)				1340	
Power Factor	Pass?	D.2.f	UL1741 Section 45.2.2	File E206704, 01NK16753, PageT1-1	Y	Measurement is reported in ratings table with one significant digit.
	Minimum power factor				1	
Harmonic Distortion	Pass?	D.2.d	UL1741 Section 45.4	File E182866, 01NK17676, PageT1-5	Y	No measurements recorded at 25% or 50%
	100% Power Total Harmonic Distortion				1.2%	

Tests (Required)	Description	Source	Reference	Verify Cross Reference	Value	Notes
	100% Power Maximum Single Harmonic				0.4%	2nd and 3rd harmonics
DC Injection	Pass?	D.2.e	UL1741 Section 45.5	UL Memo, 20020404	Y	Passed by UL design review: (Isolation transformer)
	Maximum measured dc injection current				U	
Utility Voltage and Freq. Variation	Pass?	D.2.a, D.2.c, J.2.b.4	UL1741 Section 46.2	File E182866, 01NK17676, PageT1-3	Y	Testing did not include magnitude verification. Voltage setpoints were provided on a 120V basis… values should be doubled for actual setpoints.
	Factory Fast Undervoltage (FUV) Setting			Plug Power Memo 20020426	88 Vrms	(Specified as 125V peak) (value is +/-0.6Vrms) 60 Vrms <= FUV <= UV
	Measured FUV Setting			File E182866, 01NK17676, PageT3	U	60 Vrms <= FUV <= UV
	Factory FUV Delay			Plug Power Memo 20020426	23 ms	<= 100 ms
	Measured FUV Clearing Time			File E182866, 01NK17676, PageT3	22.4 ms	<= 100 ms
	Factory Undervoltage (UV) Setting			Plug Power Memo 20020426	108.0 Vrms	(value is +/-0.6Vrms) 106 Vrms <= UV <= 120 Vrms

Tests (Required)	Description	Source	Reference	Verify Cross Reference	Value	Notes
	Measured UV Setting			File E182866, 01NK17676, PageT3	U	106Vrms<= UV <= 120Vrms
	Factory UV Delay			Plug Power Memo 20020426	30 cycles	<= 2 seconds
	Measured UV Clearing Time			File E182866, 01NK17676, PageT3	1.18 seconds	<= 2 seconds
	Factory Overvoltage (OV) Setting			Plug Power Memo 20020426	131.0 Vrms	(value is +/-0.6Vrms) 120 Vrms <= OV <= 132 Vrms
	Measured OV Setting			File E182866, 01NK17676, PageT4	U	120 Vrms <= OV <= 132 Vrms
	Factory OV Delay			Plug Power Memo 20020426	30 cycles	<= 120 cycles
	Measured OV Clearing Time			File E182866, 01NK17676, PageT4	1.62 seconds	<= 2 seconds
	Factory Fast Overvoltage (FOV) Setting			Plug Power Memo 20020426	148 Vrms	(value is +/-0.6Vrms) OV <= FOV <= 165 Vrms
	Measured FOV Setting			File E182866, 01NK17676, PageT4	U	OV <= FOV <= 165 Vrms

Tests (Required)	Description	Source	Reference	Verify Cross Reference	Value	Notes
	Factory FOV Delay			Plug Power Memo 20020426	2 cycles	<= 2 cycles
	Measured FOV Clearing Time			File E182866, 01NK17676, PageT4	4.4 ms	<= 33.4 ms
	Factory Underfrequency (UF) Setting			Plug Power Memo 20020426	59.4 Hz	~59.3 Hz
	Measured UF Setting			File E182866, 01NK17676, PageT5	U	~59.3 Hz
	Factory UF Delay			Plug Power Memo 20020426	5 cycles	<= 10 cycles
	Measured UF Clearing Time			File E182866, 01NK17676, PageT5	90.4 ms	<= 167 ms
	Factory Overfrequency (OF) Setting			Plug Power Memo 20020426	60.3 Hz	~60.5 Hz
	Measured OF Setting			File E182866, 01NK17676, PageT4	U	~60.5 Hz
	Factory OF Delay			Plug Power Memo 20020426	5 cycles	<= 10 cycles

Tests (Required)	Description	Source	Reference	Verify Cross Reference	Value	Notes
	Measured OF Clearing Time			File E182866, 01NK17676, PageT4	90.4 ms	<= 167 ms
Reset Delay	Pass?	D.1.a.3	46.2.3	File E182866, 01NK17676, PageT1-3	Y	
Loss of Control Circuit	Pass?	J.3	UL1741 Section 46.4	File E182866, 01NK17676, PageT1-13	Y	
Short Circuit	Pass?	J.3	UL1741 Section 47.3	File E182866, 01NK17676, PageT1-11	Y	Ac contact breaker did not open; would not restart; dielectric tests passed
Load Transfer	Pass?	J.3	UL1741 Section 47.7	UL Memo, 20020404	Y	Passed by design review: No off-grid operation.
Surge Withstand Compatibility	Pass?	J.3.a	IEEE/ANSI C62.45/C62.41 (Loc B3)	File E182866, 01NK17676, PageT1-8	Y	No observed change after all exposures

Note: For “Pass?” entries, Y=Yes, N=No, NA=not applicable, D=declined, U=unknown

Tests (Optional)	Description	Source	Reference	Verify Cross Reference	Value	Notes
Anti-Islanding	Pass?	UL1741	UL1741 Section 46.3	File E182866, 01NK17676, PageT1-1; ULMemo 20020404	Y	
Non-Export	Pass?	J.3.e			D	Per summary sheet
In-Rush Current	Pass?	J.3.f			NA	Per summary sheet
Synchronization	Pass?	J.3.h			D	Per summary sheet
Non-Islanding	Claimed?				Y	Per anti-islanding testing

Note: For "Pass?" entries, Y=Yes, N=No, NA=not applicable, D=declined, U=unknown